

of them, and the fact that the strength of the muscular contraction increases with the number of roots that are stimulated, would indicate that perhaps under ordinary circumstances this subdivision was a protection against fatigue; the muscle being controlled by the fibres of one root for a time and then by the fibres of the other. Different nerve elements and different muscle elements being in both cases involved.

That this subdivision is carried very far, is indicated by the fact that even the small natural bundles, composing the nerve roots, contain fibres distributed to antagonistic muscles. It is interesting to note in this connection, that at least within the enlargement of the spinal cord, the segmental arrangement of the nerve cells has been quite obliterated, and instead of cells segmentally grouped, we have long columns of cells running through several segments, and what is more, not terminating in every case at the ends of segments, but often in the middle of a segment.

The last section of this paper is something of a resumé of what is gone before, with additional data on the kind of motion produced by the stimulation of the several roots.

As regards flexion and extension in the monkey, it appears that, "of the opposed movements of joints, the one directed towards the anterior aspect of the limb, has always a spinal representation more anterior in the spinal roots than is the representation of fellow movement of opposite direction."

A Microscopical Study of Changes due to Functional Activity in Nerve Cells.

C. F. Hodge, Ph.D. (Journ. of Morphology, Vol. vii., No. 2., 1892). Since 1887 the author has spent more or less time in studying the problem, indicated by the title, and the present paper collects together, and adds to, several smaller papers which had been published during this period.

At the present time the constituent cells of different tissues are being analyzed in much the same way that, a few years since, the tissues themselves were studied, and the detail of cellular structure thus brought to light is very great indeed.

With a knowledge of the finer anatomy of the cell, it becomes possible to study the changes which take place within it under certain conditions; in this connection

the changes in the nucleus and the changes in the granulation and reticulation of the protoplasm are the ones to which attention has been directed. The paper opens with some description of changes observed in cells of non-nervous tissues as the result of their activity.

On nerve cells but very little work has been done, and the observations, thus far, made to depend upon a differential staining—reaction for cells which have been active.

The first problem, which the author had, was to determine whether changes took place in nerve cells as a result of artificially exciting them. To this end the dorsal nerve roots in frogs and cats were stimulated by electricity on the peripheral side of the ganglion; and the cells of the ganglion were then examined.

Technically the method of examination was very perfect; the cells of one ganglion, which had been stimulated, were compared with those of the symmetrical ganglion, which had been at rest.

From the animal to the slide they were passed through each stage of preparation, side by side, and treated absolutely in the same way. As a result, the differences in appearance that were found might be fairly attributed to the difference in activity which had preceded their preparation.

In both frogs and cats, micrometric examination showed that as the result of stimulation, both the cells and their nuclei had shrunk and also that the nuclei of the cell capsule had shrunk. Further, the nucleus stained more deeply with anilines, and the protoplasm stained less deeply with these and with osmic acid, and was vacuolated.

Having shown that changes did occur which could be measured, the attempt was made to see whether the amount of this change was related to the length of time during which the cell was stimulated, and to the strength of the stimulus applied.

As might be expected, if the results were genuine, such a relation was found to exist whereby, the longer the stimulus was applied and the stronger the stimulus, the greater the changes occurring in the nerve cell.

If these changes were the result of physiological processes, as they were believed to be, it would be possible for the cells to come back to their original condition; in other words, to recover from fatigue, if a certain amount of time was allowed to elapse between the

cessation of the stimulus and the death of the animal. Experiments were therefore made on the recovery of cells thus stimulated, and such a recovery was found to take place to a degree and in a manner which showed that the changes observed could be fairly ranked as physiological.

If the conclusions from these observations were correct, it was plain that these changes ought to be found in animals as a result of their daily activity, and with the rhythmical alternation of rest and activity, we should have a corresponding alternation in the condition of the nerve cells.

Birds and insects have the periods of rest and activity very sharply marked off, and a study of the nervous system, in these cases, showed that in the morning the cells were in the resting condition, whereas in the evening, after a hard day's exercise, similar cells were much shrunken, and exhibited the other changes so well marked in cells artificially stimulated.

Finally, the author points out that many so-called pathological conditions of nerve cells, as in tetanus, for example, must necessarily be considered in connection with the above observations, since the nerve cells of an individual dying after repeated and long-continued convulsions must be expected to exhibit the characteristics of exhausted cells, an appearance which does not necessarily imply that such was their permanent condition.

The plates accompanying the paper admirably illustrate the points described in the text.

By JOSEPH COLLINS, M.D.,

New York.

A Study of the Artefacts of the Nervous System.—(Van Gieson, N. Y., D. Appleton & Co. Reprinted from N. Y. Med. Jour.) Dr. Van Gieson has made a complete study of heterotopia of the cord and the results of autopsy bruises, and has embodied his labors in a monograph which marks the most important contribution that has yet been made to this subject.

Within the past few years quite a number of articles on heterotopia of the cord have seen light, and have attracted considerable attention. It was noticeable that most of the recent articles emanated from Mendel's lab-